ys 80 (8), 841-843 (2006)

Note

Dielectric properties of mixed glycine fluoride crystals

M M Khandpekar
Department of Physics, Birla College, Kalyan- 421 304, Maharashtra, India
E-mail dr_mmk1968@yahoo com

Received 2 November 2005, accepted 22 June 2006

Glycine Hydrogen Potassium Fluoride (GHKF) crystals were grown from aqueous solution by slow evaporation method for the first ...ation of conductivity with temperature (30°C - 120°C) was measured The variation in dielectric constant (K) and tangent loss of pressed ...s a function of frequency in range 400Hz - 1MHz was recorded The change in dielectric constant with temperature and applied d c bias was ...conductivity is found to be very low and decreases drastically with rise in temperature The dielectric constant is found to be independent ...d d c bias Dielectric constant (K) and tan δ decreases with frequency to attain fixed value at high frequencies, a typical of a dielectric solid ...and migrational polarisations The dielectric constant *versus* temperature curve exhibits diffused ferroelectric phase transition

Mixed glycine fluoride crystals, dc bias, conductivity, dielectric properties

78 30 -j 77 22 -d, 72 80 Jc

...ine Sulphate (TGS) class of ferroelectrics has attracted ...on of many [1 - 5] scientists resulting in development of ...phs of TGS Also it is well known that by doping such ...ls their transition temperature can be controlled While ...esence of defects like dislocations and impurities form the ...cause of their resistivity, changes in dipole moment and ...in wall motion govern its dielectric properties

...new ferroelectric material, glycine hydrogen potassium ...ide (GHKF) crystals were grown in this laboratory for the ...ime The physical behaviour of a given material may be ...cterized by the set of macroscopic measurable quantities ...as electrical conductivity, its dielectric constant *etc* In ...ice, these quantities are functions of externally variable ...meters such as temperature, pressure, frequency and applied ...[6] The anomaly in these parameters is usually interrelated ...The presence of defects influence most of the structural ...lectrical properties in such solids

...onduction in solids arises from movement of both the ions ...electric proper and the ions of foreign inculsions The ...ctric constant at low frequencies depends on factors like ...tronic, ionic, dipole orientation and migrational (space-...ge) polarisations The plot of K against frequency indicates the contributions of these parameters The permittivity-frequency relationship describes the dispersion characteristic of a dielectric A monotonic decrease in permittivity with increase in frequency indicates relaxation dispersion This is a characteristic of a dipole and migrational polarisation

The dielectric loss in solid dielectric materials must be considered in connection with their structure Because solids differ in structure and composition in great varieties of ways, they can display all types of dielectric loss The dielectric loss further depends on temperature displaying a maximum and a minimum of loss

Ferroelectric materials are crystalline substances which display a spontaneous polarisation whose direction can be reversed under external influences like an electric field One more specific parameter of these materials is the ferroelectric Curie temperature At Curie point, the crystal passes from a ferroelectric to paraelectric phase The phase transformation is of three types including the diffused one In the first kind of ferroelectric phase transition, the spontaneous polarisation abruptly drops to zero at the Curie point, the Curie- Weiss temperature being low than the Curie temperature In the second kind, these two temperatures are equal. In the third (diffused) kind, the definite transition point is absent and the transition occurs over a broad temperature region (Curie region) In this region, ferroelectric and paraelectric phases are said to coexist

Hence, studies of interest such as the variation of conductivity with temperature and dielectric constant with temperature, frequency (tan δ) and applied d c bias were carried out on GHKF and are presented here

Glycine, hydrogen fluoride and potassium fluoride, all AR Grade (Merch, India Ltd) in molar ratio 3 0 5 0 5 were mixed in distilled water and kept at 35°C and whitish crystals (0 5 - 1 0 cm) were obtained in about 4-5 weeks time The crystals had many flat faces and lacked good cleavage, hence, they were pressed in form of pellets and subjected to electrical characterization

Variation of dielectric constant with d c bias and frequency and tan δ was made using HP 4284 (400Hz- 1MHz) precision LCR-Q meter For the measurements of conductivity and dielectric constant with temperature, CIE 5125 make digital multimeter with 2000 Megaohms range was employed

Conductivity (σ) against temperature (1/T)

The variation of conductivity with temperature (R T to 120°C) was studied (Figure 1) The overall conductivity of the sample is low as reported by Whipps *et al* [9] With rise in temperature, it decreases rapidly upto 68°C to become constant At lower temperatures, impurities are predominant whereas at elevated temperatures, some ions may detach from the sites of crystal lattices [10] Further, this nature is attributable to a diffused phase transition The low value of conductivity is associated with the presence of impurities

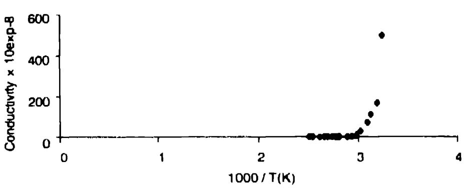

Figure 1. Conductivity *versus* 1/T (K) plot

Dielectric constant Verses d c bias (V /d)

Figure 2 shows with application of d c bias in range from (0- 63 Volts /Cm), the dielectric constant (K) decreases only marginally to become constant, *i e* it is independent of applied d c fi[...] However, the small value of K is ascribed to the domain cla[...] effects seen in such samples [11]

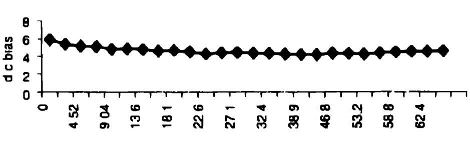

Figure 2 Dielectric constant (*K*) *versus* d c bias (V/cm)

Dielectric constant(K) and tan δ with frequency

Pressed specimens contain voids, grain boundaries and [...] defect The presence of voids decreases the dielectric con[...] in general [12]

Figures 3 and 4 show the variation of the dielectric cons[...] (K) and tangent loss (tan δ) factor with frequency (40[...] 1MHz) At lower frequencies, K is high and decrease[...]

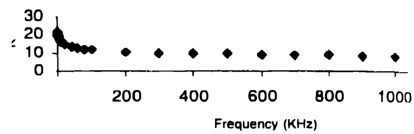

Figure 3 Dielectric constant *versus* frequency plot

increase in frequency to attain a fixed value at higher frequen[...] The variation of dielectric constant with frequency s[...] polar dielectric Moreover, a monotonic decrease in K [...] increase in frequency (relaxation dispersion) is typical for di[...] and migrational polarisation The value of K is also attribute[...] defects [13,14] The nature of Loss tangent curve is a typica[...] dielectric solids The growth in the loss beyond a minimum p[...] is attributed to increase in the leakage loss

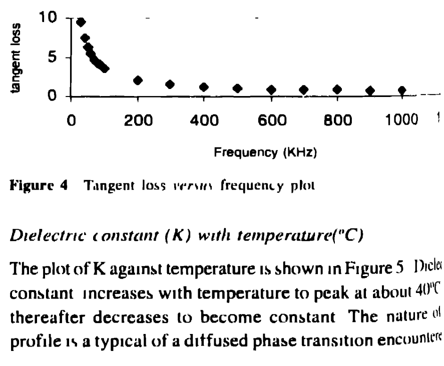

Figure 4 Tangent loss *versus* frequency plot

Dielectric constant (K) with temperature(°C)

The plot of K against temperature is shown in Figure 5 Diele[...] constant increases with temperature to peak at about 40°C thereafter decreases to become constant The nature of profile is a typical of a diffused phase transition encounter[...]

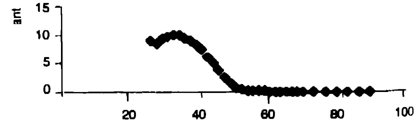

Figure 5 Dielectric constant *versus* temperature (°C)

roelectric materials Here, the phase transition is said to occur broad temperature range with coexistence of the ferroelectric the paraelectric phases [15].

New mixed glycine fluoride crystals have modified habitats lack good cleavage planes The conductivity is low at room perature and is influenced by presence of impurities and ects The dielectric constant is found to be independent of applied d c field (bias) The variation of dielectric constant h tan δ and frequency suggests a dielectric solid with dipole migrational polarisations The variation of dielectric constant mperature exhibits diffused phase transition

rences

[1] G Arunmozhi , E de M Gomes J L Ribeiro and J A Mendes *Ferroelectrics* **302** 305 (2004)

[2] Wencheng Hu Chuanien Yang, Wanli Zhang and Xiyi Liao *Ferroelectrics* **315** 83 (2005)

[3] J Novotny J Zelinka and Z Podvalova *Ferroelectrics* **313** 1

[4] E Soergel *Appl Phys* **B 81** 6, 729 (2005)

[5] S A Grindev *Ferroelectrics* **266** 507(2002)

[6] A J Dekkar *Electrical Engineering Materials* (India Prentice Hall India Ltd) p1(1991)

[7] R Pepinsky K Vedam, S Hoshino and Y Okaya *Phys Rev* **111** 430 (1958)

[8] R Pepinsky, K Vedam S Hoshino and Y Okaya *Phys Rev* **111** 1508 (1958)

[9] P W Whipps, R S Cosier and K L Bye *J Mater Sci* **7** 12 1476 (1972)

[10] M M Khandpekar *Ph D Thesis* (University of Mumbai, India) p185 (1994)

[11] S Hoshino, T Mitsui F Jona and R Pepinsky *Phys Rev* **107** 5, 1256 (1957)

[12] C J F Bottcher *Theory of Electrical Polarization* (Amsterdam Elsevier) (1952)

[13] G D Nigam *Indian J Pure Appl Phys* **14** 216 (1976)

[14] H R Danner and R Pepinsky *Phys Rev* **99** 1215 (1955)

[15] B M Tareev, N V Korotkova, V M Petrov and A A Preobrazhensky *Electrical and Radio Engineering Materials* (ed) B M Tareev (Moscow Mir) p 241 (1980)